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June 5, 1989

Ref: 1091C/890605

US EPA, Region VII
726 Minnesota Avenue
Kansas City, Kansas 66101

Attn: **Mr. Glen Curtis**

Re: **Field Operations Plan - Cherokee County: Test Addendum**

Dear Mr. Curtis:

Attached please find the addendum to the Field Operations Plan for the testing portion portion of the pilot leach testing program being undertaken by the participating PRP group.

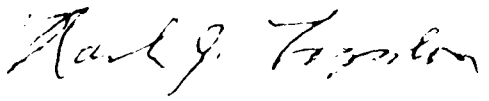
The FOP has been discussed in our conference call of June 2, 1989, and comments and suggestions from that discussion have been incorporated. Copies of the plan will be available in the field at all times.

I trust that you will find this letter and the attached Field Operations Plan addendum acceptable. If you have questions about this letter or our FOP, please contact me directly. Outside of MDT business hours, you or your staff may contact me by telephone at 303/322-2399.

We anticipate being ready to begin testing by June 8, 1989. Thus, we would greatly appreciate your reponse to our plan at your earliesty convenience. Per our discussion of last week, I am sending copies directly to Mssrs. Geitner and Glanzman at CH2M Hill.

Nothing in this letter is to be construed as altering the terms or conditions of the Professional Services Agreement between Adrian Brown Consultants, Inc. and the Participants (Amax Mineral Resources Company, NL Industries, Gold Fields American Corporation, ASARCO, and Sun Company, Inc.). Because Adrian Brown Consultants is an independent contractor, the firm is not authorized to speak on behalf of the Participants with respect to any matters outside the scope of the current agreement. In particular, no statement by Adrian Brown Consultants or any of its employees or subcontractors may be considered an admission or waiver of any defense by any or all of the PRPs concerning liability for response costs or concerning the propriety of U.S. Environmental Protection Agency's actions at the Cherokee County site as a whole or the Galena subsite in particular.

Sincerely,
ADRIAN BROWN CONSULTANTS, INC.



Mark J. Logsdon, Project Manager

cc: K.R. Paulsen (AMAX)
B. Sams (NL)
A. E. Godduhn (Gold Fields American)
J. Richardson (ASARCO)
L. Grossi-Tyson (Sun)

1.0 INTRODUCTION

This document is the addendum to the Field Operations Plan (FOP) of May 2, 1989 for the PRP Participants' Pilot Testing Program, to be conducted in May and June 1989 at the Galena Subsite of the Cherokee County Superfund Site in Kansas. This addendum addresses the design and implementation of the batch and flow-though leach tests. The Participating PRPs' investigations will provide technical assistance to support design development of a portion of one of the remedial actions for the Groundwater and Surface Water Operable Unit. This work has been reviewed and approved in concept via the approved Technical Assistance for Galena Subsite Mine Waste Characterization, Work Plan Revision Request No. 3, dated April 14, 1989. The introductory material on site characteristics presented in the original FOP will not be repeated here.

2.0 TEST OBJECTIVES

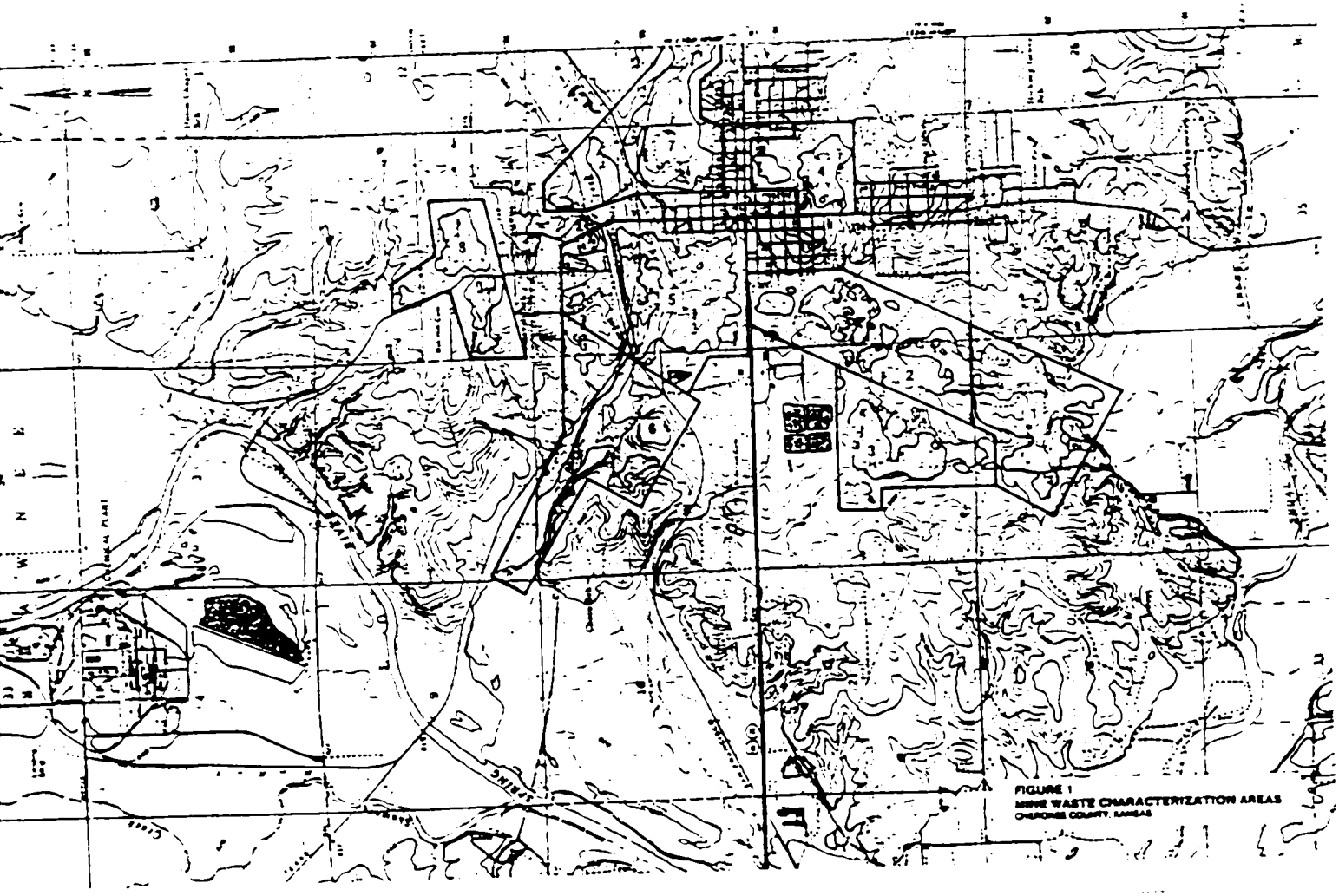
The objective of the pilot leach tests is to establish the expected geochemical response of leaching coarse mine waste rock and low-zinc chat with actual site ground waters. In addition to the geochemical data, the test program will provide data to be used in determining optimal practical size to be used in future screening and disposal activities and additional data on permeability of backfilled material and its possible impact on groundwater flow. It is considered that the testing program will provide important information for selecting a preferred remedial action at the Galena subsite.

The leach tests described in this addendum to the Field Operations Plan (FOP) will include short-term batch leaching experiments and long-term flow-through experiments. The short-term batch leaching experiments are designed to test the potential effects on water quality of various parameters of the model remedy, including the importance of grain size, materials handling alternatives, and the ranges of waste rock chemistry and water quality that were determined during the initial field characterization phase.

The flow-through experiments will test larger volumes of representative waste-rock and chat under consistent flow conditions to assess the potential impact on water quality in a dynamic system. The experiments will test both calcareous and siliceous waste rock using a consistent water chemistry, with an additional experiment that varies the chemistry by mixing the groundwater with a synthetic "rainwater" to test the potential effects of major precipitation events on short-term water quality.

Approximately 10 tons each of reasonably representative, composited waste rock and low-zinc chat have been collected, sampled, and stockpiled in the field for use in the pilot leach testing. A secure test location has been established (and will be fenced during actual testing) and reaction vessels for the flow-though tests are in place. The water supply for the flow through tests has been determined as Pond 524, located in EPA Area 5, immediately north of the Galena Municipal Complex (Figure 1). Details of the proposed leach tests are presented below.

FIGURE 1 Location Plan



3.0 TEST PROCEDURES, LOCATIONS, AND EQUIPMENT

All leach tests will be conducted in the designated, secure test site in Area 5. Water for batch tests from subsidence features other than Pond 524 will be collected and transported to the test area, where all the waste rock and chat is stockpiled and equipment for handling the rock is readily available.

As discussed on June 2, 1989 in a conference call between M. Logsdon (ABC), K. Paulsen (AMAX), G. Curtis (EPA/VII), and R. Glanzman, D. Nicholson and J. May (CH2M Hill), waste rock and low-zinc chat will be physically mixed in flow-through tests and selected batch tests to maximize the reproducibility of those tests. By agreeing to the mixing of materials for the purpose of this test, ABC is not providing a commitment on behalf of the PRPs that field-scale mixing during an actual remedial action is contemplated or would be reasonable or appropriate. Furthermore, it is recognized that mixing will likely overestimate reactivity in comparision to a layering of waste rock and chat because the fine-grained material will be available throughout the flow field with relatiely uniform permeability; in a layered system such as would likely be developed using heavy equipment, distribution of flux will be controlled by permeability, and most of the flow will move through the highest permeability (and presumably the lowest reactivity) materials.

3.1 POND 524 WATER QUALITY

Water from Pond 524 (Figure 1) will be used for all three flow-through tests and for at least 7 batch tests. Pond 524 was chosen for four major reasons:

- Area 5 contains a large amount of waste rock and chat;
- Pond 524 is large and deep, with a significant volume available for potential disposal;
- The water quality in Pond 524 is relatively poor, increasing the likelihood that the water would leach metals, if they are available;
- The test location is in line-of-sight of the Galena Police Department, allowing significant security advantages throughout the pilot leach testing.

Based on the field sampling and the preliminary data report from PSI - Bruce Williams Laboratory in Joplin, Missouri, the Pond 524 water has the following critical chemical aspects:

Parameter	Units	Value
pH	su	4.4
Specific Conductance	umho/cm	525
Oxidation Potential	mV	378
Dissolved Oxygen	ppm	5.6*
Temperature	degrees C	20**
Sulfate	mg/L	220
Cadmium	mg/L	.098
Lead	mg/L	-.010
Zinc	mg/L	50.8

Notes: *: DO at mid-depth; range 0.57 - 7.9 ppm
**: Temperature at mid-depth; range 16.1 - 25.9 dgrees C
-: "Less than"

Additional batch tests will be performed with water from ponds in EPA-designated Areas 1, 4, 6, 7, and 8. Data from these water are presented in Attachment 1, and samples will be taken from each test vessel prior to initiating the actual batch tests.

3.2 BATCH TESTS

3.2.1 Standard Procedures

For all 12 anticipated batch tests, standard procedures will be used:

- All batch tests will be conducted in clean 55 gallon drums. The drums will be washed with test water prior to charging with test water and rock. The field team will attempt to arrange shade for the vessels to minimize temperature effects during the static tests.

- All batch test barrels will be filled completely with test water, covered with a lid, and transported to the common test area.

- All batch test barrels will be allowed to stand for at least 8 hours after arriving at the test site to allow air entrained in transport to escape to the surface. Prior to sampling, they will be tested with the Martek Mark XVII probe for pH, conductivity, DO and temperature to assess stratification and gently agitated to mix the water without entraining air. Two (2) liters of water will be withdrawn

from approximately mid-depth in the barrel using a peristaltic pump for chemical analysis of the starting fluid.

- Following sampling of the initial fluid, the selected rock charge will be gently introduced (to avoid entraining air in the restricted volume) into the barrel. The overflow water will be collected to determine the final volume of rock introduced. The goal of the charging will be to produce a volumetric water:rock ratio of 2:1, consistent with the batch leaching tests conducted by the PRPs in 1988. Because a 55-gallon barrel will hold approximately 800 pounds of rock (depending on grain size), it is anticipated that each batch test will consist of approximately 200 pounds of waste material and approximately 40 gallons of test water.

- Following charging of the barrel and measurement of displaced water, the lid will be reattached and sealed with tape and water-proof putty (the putty will be tested for any metals), and the barrel will be rocked back and forth or rolled over several times to agitate the mixture.

- Following agitation, the barrel will be left to stand for 24 hours before sampling. Sampling will be performed by tapping the barrel at approximately mid-height, draining approximately 1 gallon of leachate and then collecting approximately two liters of sample for analysis. Split (replicate) samples will be collected to meet the QA/QC goals, representing at least 10% of the samples.

3.2.2 Designation of Batch Leach Tests

It is anticipated that approximately 12 batch tests will be performed using the procedures described above and the following test materials.

- Test 1: WATER: Pond 524
  ROCK: 1:1 mixed, +2" screened siliceous waste rock and low zinc chat

- Test 2: WATER: Pond 524
  ROCK: 1:1 mixed, +2" screened calcareous waste rock and low-zinc chat

- Test 3: WATER: Pond 524
  ROCK: 1:1 layered, unscreened siliceous waste rock and low zinc chat

- Test 4: WATER: Pond 524
  ROCK: 1:1 layered, +2" screened siliceous waste rock and low-zinc chat

- Test 5: WATER: Pond 524
  ROCK: unscreened siliceous waste rock without chat
- Test 6: WATER: Pond 524
  ROCK: +2" screened siliceous waste rock without chat
- Test 7: WATER: Pond 524
  ROCK: low-zinc chat without waste rock
- Test 8: WATER: Pond 14
  ROCK: 1:1 layered, +2" screened siliceous waste rock and low zinc chat
- Test 9: WATER: Pond 617
  ROCK: 1:1 layered, -2" screened siliceous waste rock and low-zinc chat
- Test 10: WATER: Pond 720
  ROCK: 1:1 layered, +2" screened siliceous waste rock and low zinc chat
- Test 11: WATER: Pond 816
  ROCK: 1:1 layered, +2" screened siliceous waste rock and low-zinc chat
- Test 12: WATER: Blue Hole
  ROCK: 1:1 layered, +2" screened siliceous waste rock and low-zinc chat

This program of batch tests will allow early assessment of the maximum expected leachability for the flow-through tests (Batch Tests 1 and 2), evaluation of the range of difference that might be expected from different material handling decisions, and assessment of the range of variation that may be due to different initial water chemistry.

3.3 FLOW THROUGH TESTS

3.3.1 Test Vessels

Three flow-through tests are planned, two using siliceous waste rock and low-zinc chat and one using calcareous waste rock and low-zinc chat. The two siliceous tests will be replicate tests, designed to duplicate all procedures and materials to the extent practicable. Each of the flow-through tests will be performed at the central test area in EPA-designated Area V, using water from

Pond 524. A particular phase of the test, to be described below, will use a mixture of Pond 524 water and artificial "rainwater".

The design of the test vessels is shown in Figure 2, from which the reaction vessels have been constructed. The essential features of the vessels include:

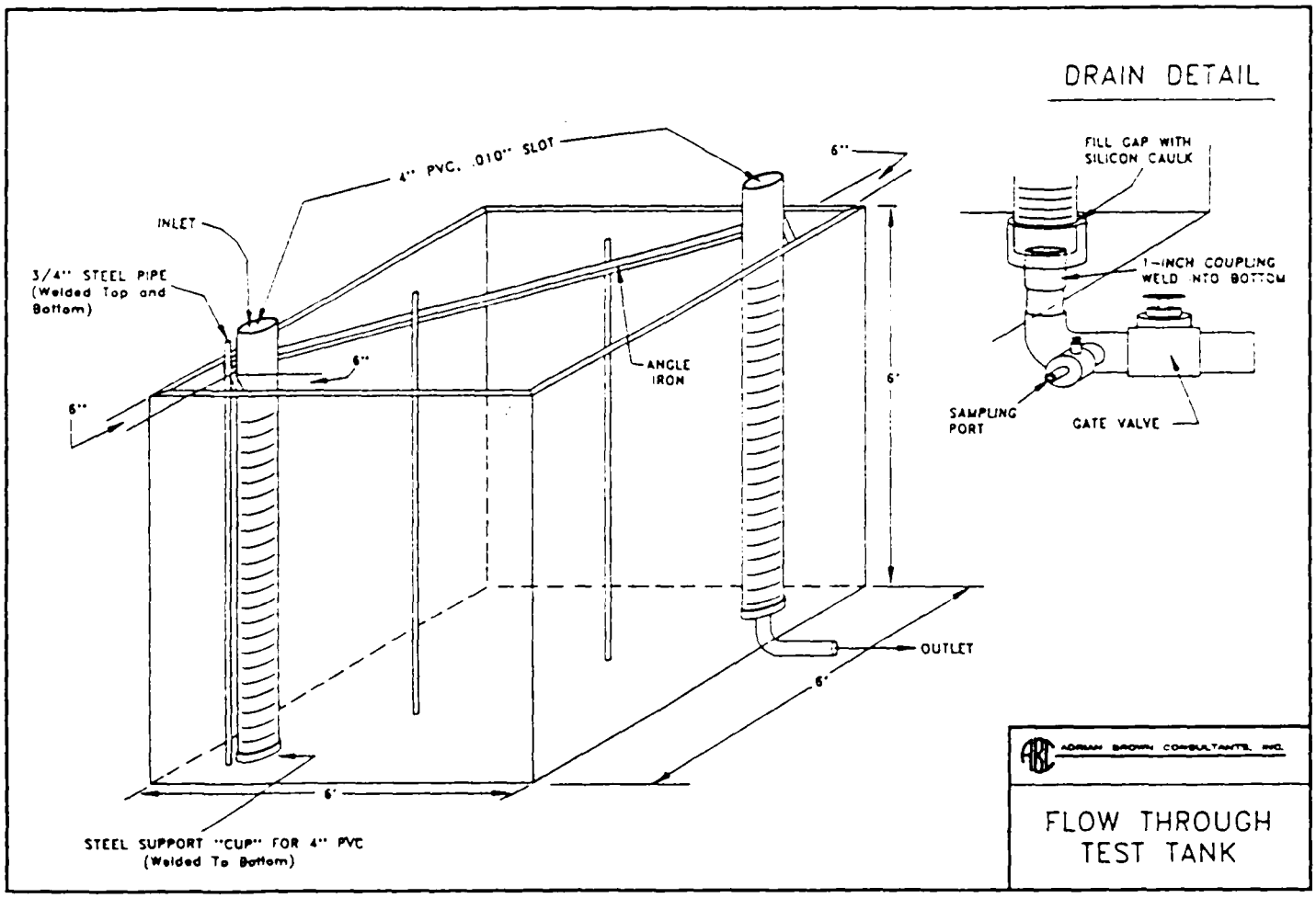
Total dimensions: 6' x 6' x 6'
Total volume (empty): 8 cubic yards; approx. 1600 gallons
Total volume of water when fully charged with rock: approx. 500 gallons (assumes porosity of approximately 0.30)
Mean flow path length (well-to-well): 8 feet
Injection well: 4" PVC, held at constant head
Drain well: 4" PVC, held at constant flow of 2 gpm
Design-basis hydraulic gradient: approximately 0.01
Flow-field piezometers: two 1" piezometers installed at regular intervals between the injection and drain wells.

3.3.2 Procedures

The test procedures for each of the three tests will be identical:

- Mix the waste rock and chat at a volume ratio of 1:1 with the bucket to achieve as homogeneous a mixture as possible.
- Fill the reaction vessels with test water and profile for pH, conductivity, DO and temperature with the Martek M XVII tool. After profiling draw a sample from each vessel, plus at least two QA/QC splits (plus splits for EPA, as required), for analysis of starting composition.
- Using the backhoe bucket, fill the reaction vessels with the mixed waste rock - chat charge. The reaction vesel should be filled completely, and the overflow collected and measured, to the extent possible, to determine water-rock ratios.
- Cover the reaction vessels and emplace the header tank(s).
- Leave the tanks fully charged, but with no flow for 24 hours to perform an initial batch test. At the end of 24 hours, collect samples (including QA/QC splits) for analysis.
- Establish the initial head condition for the injection wells and adjust the outflow to 2 gpm to initiate the test.

FIGURE 2 Flow Through Test Tank



- Measure water levels in the piezometers and collect samples from the drain well at the following elapsed time intervals:

  - Initiation of flow through test plus:

1 hr	48 hr (day 2)
3 hr	72 hr (day 3)
6 hr	96 hr (day 4)
12 hr	
24 hr	

  At least 10% of the samples will be collected in replicate (splits), and splits for EPA will also be taken at the direction of the oversight personnel.

- After the 96 hour sampling (end of day 4), introduce a 1:1 volumetric ratio of test water and "rainwater", sufficient to displace one pore volume of the test tanks. The effluent from this test shall be collected at elapsed hours 97, 102, 108, and 120 (i.e. for 24 hours after initiation of the mixed-water test). After the initial mixing of test water and "rainwater" was been used, the test wll return to the standard Pond 524 test water.

  The artficial rainwater will be constructed in the field using Galena system water, pH adjusted to 5.0 using a 60:40 mixture of sulfuric:nitric acid. This method is approximately equivalent to proposed EPA Method 1312 for leaching of large-volume/low hazard wastes (54 FR 15316), and it is intended to provide a pH-adjusted leachate that is representative of rainwater common west of the Mississippi River. The principal difference between this proposal and Method 1312 is that the base water is not distilled, since such large volumes (approximately 500 gallons may be needed) of distilled water are not readily and economically available. The Galena system water is sufficiently low in TDS that it is a suitable surrogate, once the pH has been adjusted. Note that the pH of this artificial "rainwater" is higher than that of Pond 524. Samples of the base water and the pH-adjusted base water will be collected for analysis to determine the effects, if any, of using system water in the test.

- Regular sampling on 24-hour intervals after the "rainwater" test until three successive samples show no variation in pH, conductivity and temperature or until 10 days (240) hours of elapsed time in the test.

- At the conclusion of the test, the ABC field team will perform a step-drawdown test at four different flow rates (approximately 1 gpm, 2 gpm, 5 gpm and 10 gpm). The water levels in the piezometers will be monitored during the

drawdown test, and the data will be analyzed by standard methods to assess the permeability of the test materials.

At the completion of the tests, the vessels will be drained and the test materials returned to the stockpiles. All anthropogenic test materials will be removed from site, and the area will be policed to return the test area to as close to its original conditions as possible.

4.0 DOCUMENTATION

Field logbooks, photographs, and other sampling documentation shall be maintained during all phases of the leach testing to provide an adequate project record.

5.0 EQUIPMENT REQUIREMENTS

3 6' x 6' x 6' steel tanks, painted internally, with plumbing
Piezometers and injection/drain wells emplaced in tanks
M-scope
Tape measure
2 and 5 gallon buckets
Water pump (electric)
Generator
Water pipe
Electrical cables
Camera
Field logbooks
Water quality profiling unit - Martex Industries M-XVII
Cubitainers
Laboratory-supplied sample bottles/preservatives
Laboratory-supplied insulated coolers
Field pH-conductivity meter
Raft
Backhoe
Sample documentation
Chain-of-custody
Field Operations Plans/QAPP
Site Safety Plan
Site access approvals
Site access permission forms
Protective clothing
Security fencing

6.0 FIELD TEAM ORGANIZATION, RESPONSIBILITIES, AND SCHEDULE

The field team will consist of the following positions. A single individual may be responsible for more than one position.

- Field Program Manager (FPM). The FPM will be responsible for day-to-day planning, scheduling, and execution of the sampling plan.
- Site Safety Officer (SSO). The SSO will be responsible for enforcing the Site Safety Plan thoughout the field investigation.
- Field Team Leader (FTL). The FTL is responsible for maintaining field log books, completing the documentation of all sampling activities, and gathering necessary equipment for each day's work.
- Sampling Technicians. The samplers are responsible for proper collection and handling of the samples. They will work under the direction of the FTL.
- Documentation Coordinator. The documentation coordinator is responsible for all aspects of sample documentation.

The field investigation activities described in this document are scheduled for June, 1989. It is estimated that the leach testing can be completed within ten days from initiation of actual flow-through conditions.

The first day will be primarily spent organizing and testing equipment and mixing waste materials. The second day will be spent charging the test tanks and collecting initial water samples. The flow through tests will begin first (because they will take up to 10 days to complete), with the batch tests to be performed when the three flow-through tests are stabilized and in normal operating conditions. The batch tests should be complete and sampled by day 4, with the flow-through tests continuing for at least 5 days, and perhaps as much as 10 days, depending on the results that are observed. The final step-drawdown test will be performed on the flow-through tanks after the last sample has been drawn.